

## OBSERVATION OF THE RUSSIAN MOON PROBE "LUNA 10"

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## OBSERVATION OF THE RUSSIAN MOON PROBE "LUNA 10"

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The moon probe Luna 10 was launched in USSR on 31 March 1966. As in earlier probe experiments, Luna 10 was lifted by a booster vehicle to a parking orbit around the earth and then launched from this parking orbit on its way to the moon. The COSPAR designation of Luna 10 is 1966-27 A. Another body with the designation 1966-27 B orbited the earth at a height of about 150 km and is probably identical with the carrier vehicle which lifted the moon probe and the propulsion unit of the latter into a parking orbit around the earth.

### 1. Introduction

Detailed study of the physical state of the space between earth and moon is a controlling prerequisite for any non-manned or manned project for reaching the moon. On the basis of these problematics, both the US and the USSR have carried out in recent years a large number of experiments, e.g., the satellites of the IMP, Ranger, and Pioneer series of the US and the Luna series of the USSR which reached a climax with the successful soft landing of Luna 9 on the moon (Ref. 1). Since the US just like the USSR certainly intends to place not only automatic measuring stations on the moon but also manned landings, the following questions result:

1) Determination of the temperature regime of the moon surface. Measurements have already been made from the earth but are subject to the restricting influence of the terrestrial atmosphere.

2) Determination of the frequency and distribution of meteorites and meteorite showers in the area between earth and moon. This has particular importance since the moon does not possess an atmosphere which would shield the surface of the moon from the greater part of the meteorites.

3) Determination of the magnetic field of the moon in regard to intensity and orientation.

4) Determination of the gravitational field of the moon and investigation of the homogeneity of this field. This is of particular interest for questions concerning the creation of the moon.

5) Investigation of the radiation components of the moon surface, e.g., radioactivity. This is of importance for manned exploration of the moon because it can be assumed as certain that the surface of the moon behaves in regard to radiation differently from the surface of the earth. This is due to the fact that the surface of the earth is shielded by its atmosphere against direct radiation from space and from the sun. Only secondary radiation components of the primary space radiation reach the surface of the earth. However, cosmic and solar radiation acts directly on the surface of the moon. During radio-observation of the moon probe Lunik 2 in September 1959, the author drew attention to an ionization of the moon surface and its boundary areas from changes (observed by him) of the radio waves in the 20-Mc/s range emitted shortly before the impact of the probe.

Prior to a manned moon project, the above questions must be clarified sufficiently to result in the necessary safety for executing the experiment. The intensity of treatment of these questions in the research program of the two space-flight nations will permit logical conclusions in regard to the contemplated manned moon explorations.

## 2. Observational Facilities

The transmitted frequency of 183.535 Mc/s of Luna 10 was known from the Luna-9 experiment and through communications reaching the Institute (Institute for Satellite and Space Research of the Astronomical Observatory of the City of Bochum) from Russia. Work on the 20-m parabolic antenna of the Institute had progressed sufficiently at this time so that the azimuth and elevation units and indicator instruments of the antenna were operational. A crossed dipole antenna of the Fuba Company was mounted provisionally on the Cassegrain reflector of the antenna (Figs. 1 and 2). Measuring of the diagram of the provisional receiving antenna indicated an antenna lobe with an aperture of  $12^\circ$ . The Company for the control system of the antenna collaborated in the experiment by voluntarily working overtime. This made possible temporary provisional operation of the antenna installation. With the assistance of other firms and authorities, it was possible to complete the installation sufficiently so that transmissions from the moon probe Luna 10 could be received.

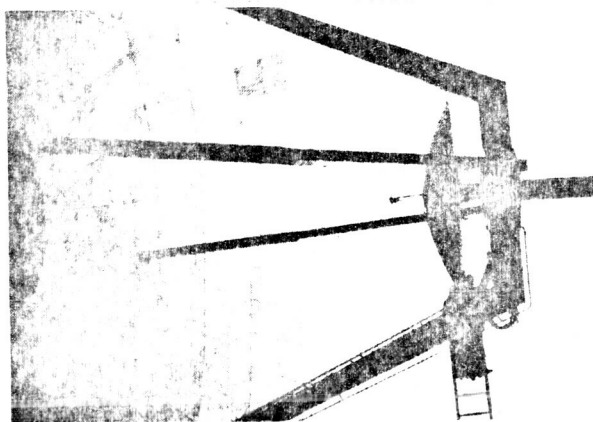


Fig. 1 - Mounting of 183-Mc/s converter on rear of Cassegrain reflector of 20-m parabolic antenna.

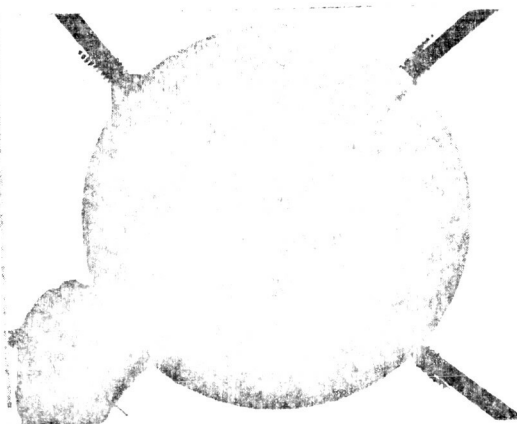


Fig. 2 - Crossed dipole antenna for 180 Mc/s mounted provisionally on the Cassegrain reflector.

### 3. Receiving Installation (Fig. 3)

The converter for 183.5 Mc/s was mounted on the rear of the Cassegrain reflector so that the length of cable between dipole and converter was only 2.5 m. The noise level of the converter with a 47-4 resonant circuit was 4 dB. The converter changed the input frequency of 183.5 Mc/s to an intermediate frequency of 28.535 Mc/s which was conducted to the antenna distributor. From the latter the signal was conducted to the control room of the parabolic antenna and the intermediate frequency conducted to the actual receiving system with the standard filter. In the control room, the intermediate frequency received

measuring receiver with subsequent field-intensity recorder. This provisional receiving system made it possible to test the orientation of the antenna with the aid of maximum adjustable field intensity. For control of the receiving frequency, a decade XUA was remote-controlled from the central standard time and frequency installation Rhode & Schwarz, Type CAC, and selectively switched to the input of the converter for establishing the accurate receiving frequency.

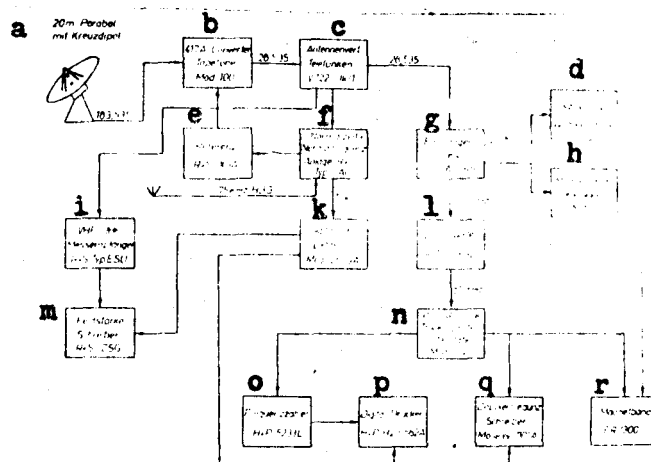


Fig. 3 - Diagram of receiving installation for Luna 10.

**LEGEND:** a - 20-m parabolic antenna with crossed dipole; b - converter, tape tone; c - antenna value, Telefunken; d - oscilloscope; e - reference; f - standard time and frequency installation; g - receiver; h - magnetic tape, Telefunken; i - VHF and UHF measuring receiver; k - digital converter; l - intermediate frequency converter; m - field-intensity recorder; n - phase-lock tracking filter, interstate; o - frequency counter; p - digital printer; q - Doppler-frequency recorder; r - magnetic tape.

From the antenna distributor, the intermediate frequency for main reception was transmitted to a short-wave receiver Collins R-390. The intermediate frequency of 455 kc/s was changed by an intermediate-frequency converter to 50 kc/s. The converted intermediate frequency reached a phase-lock tracking filter with subsequent frequency counter/digital printer and doppler-frequency recorder (Fig. 4). The equivalent noise band width of the tracking filter was 10 c/s. The converted intermediate frequency was directly recorded on an Ampex magnetic tape FR-1300 with the addition of the demodulated signal from the tracking filter. The low-frequency output of the kW-receiver R-390 was recorded on a magnetic-tape instrument, Type Telefunken M-5.

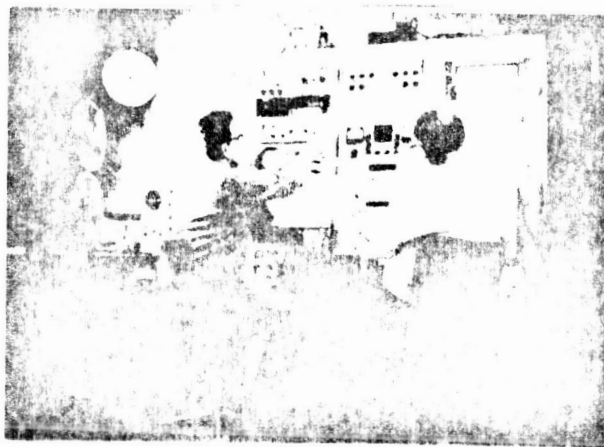


Fig. 4 - Control desk for Luna 10 with tracking filter, etc.



Fig. 5 - Control desk of 20-m parabolic antenna with field-intensity recording.

#### 4. Reception

Observations began with moonrise at 1525 hour GMT on 3 April 1966. The 20-m parabolic antenna was manually set to the calculated azimuth and elevation values of the moon. After the moon had risen, telemetry was begun (Fig. 5). The latter suddenly stopped around 1844,30" hr GMT according to information from the USSR. This was the instant at which the control system of the space probe was ordered to initiate the retarding device for placing the probe on a moon orbit. The most extensive telemetric transmission in time from Luna 10 was recorded between 1846,50" and 2121,12" hr GMT after deflection into the Luna orbit. From this were evidently obtained the data which determined the further progress of Luna 10. From this long-interval recording, it was possible to arrive at an approximate duration of the lunar orbit which had to be greater than 2

hours. Between 1900,44" and 1900,50" hr GMT, the beginning of the "International" was received and recorded. Recordings of field-intensity from Luna 10 then were made at the following times (Fig. 6):

3 April 1966: 1846-1903; 1943-1955; 2025-2058; 2228-2255 hr GMT.

4 April 1966: 0017-0023; 1702-1735; 2001-2020; 2119-2129; 2207-2213; 2302-0020 hr GMT.

It was apparent after very few observations that Luna 10 did not transmit continuously but sent the measured values according to a given time schedule.

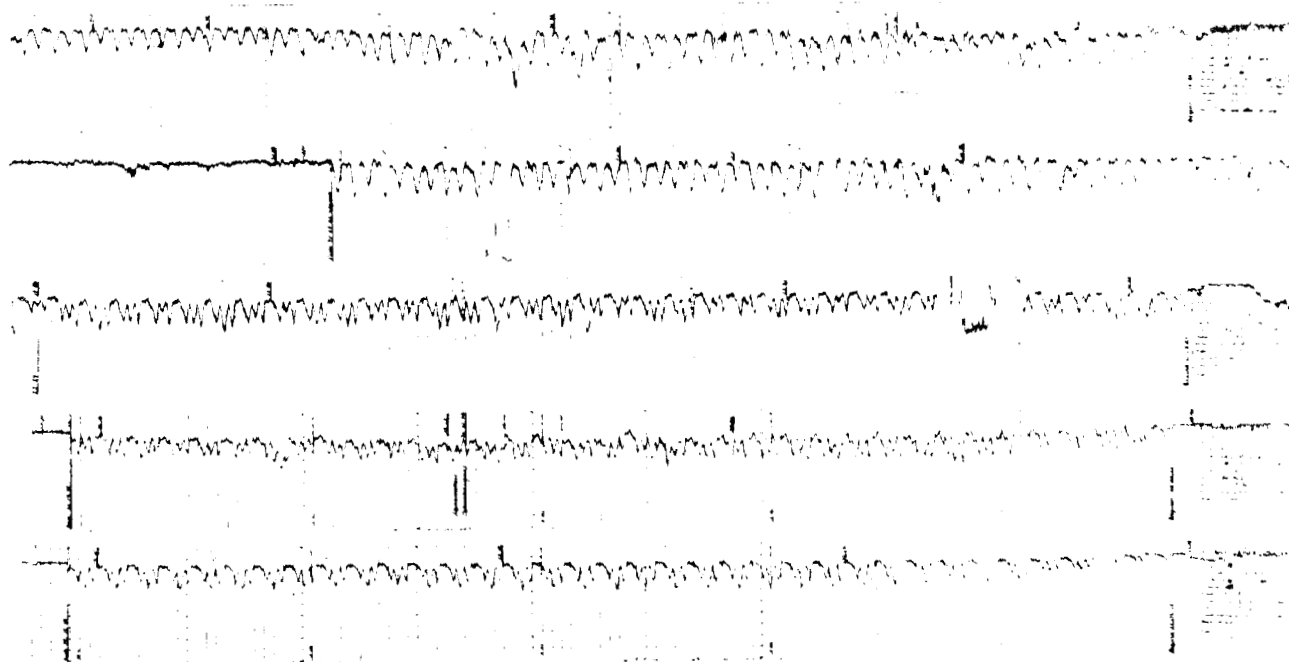


Fig. 6 - Field-intensity diagrams of Luna 10.

Determination of the Doppler effect repeatedly showed that the transmitter of Luna 10 executed periodic frequency changes around  $\pm 2.5$  kc/s and subsequently adjusted to the standard frequency of 285.325 Mc/s. Several recordings of the single Doppler effect were made (Fig. 7). After a few hours of observation, the interpretation of the measured Doppler effect indicated definitely that Luna 10 was orbiting the moon with the following orbital data:

"Periselenium"  
"Aposelenium"

250 km  
1017 km

Orbital period  
Orbital inclination to lunar equator

2 hours 58'15"  
71°54'

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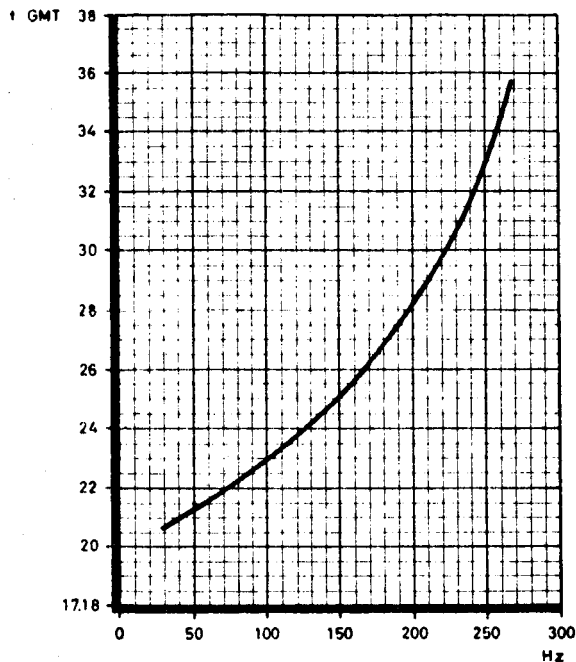


Fig. 7 - Recording of Doppler effect from 1720 to 1736 GMT.

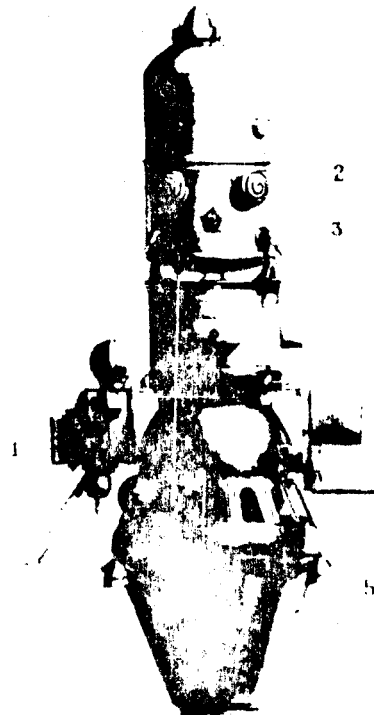


Fig. 8 - Luna 10. 1 - telemetering transmitter; 2 - satellite body; 3 - separation system of satellite; 4 - navigational star sensors; 5 - space-propulsion unit.

## 5. Description of Probe

Luna 10 consisted of two components, the actual moon satellite and the space-propulsion unit (Fig. 8). At 1844,30" hr GMT, the propulsion unit was ordered to ignite in order to reduce velocity from 2.1 km/sec to 1.25 m/sec. This deflected the moon satellite into an orbit around the moon. Twenty minutes later the propulsion unit was separated from the satellite. The temperature of the satellite varied between 24 and 26° C and pressure was 850 mm Hg (Ref. 2).

## 6. Summary

With the almost completed 20-m parabolic antenna of the Institute for Satellite and Space Research of the Astronomical Observatory of the City of Bochum, it was possible to receive, through temporary improvisation, the transmissions of the Russian moon probe Luna 10 on a frequency of 183,535 Mc/s between 3 and 5 April 1966. Telemetering, field intensity and Doppler effect were received and recorded perfectly over the distance to the moon. The maximum of the field intensity recorded was around 7 to 8 dB above the noise level. Observations were discontinued after 5 April 1966.

### References

1. Observations of the Russian Moon Probe Luna 9, Nature, Vol. 209, No. 5026.
2. The Soviet Union Today, 11. Jahrgang, 16.4.1966.
3. H. Kaminski, The New Institute for Satellite and Space Research in Bochum, Raketentechnik und Raumfahrtforschung, Heft 2, April-June 1962.